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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

INVENTOR: Densen Cao

DOCKET: 5045.2 P

TITLE: **Semiconductor Light Source**

FILED: August 24, 2001

SERIAL NO.: 09/939,339

ASSIGNEE: Cao Group, Inc.

Assistant Commissioner for Patents
Washington, DC 20231

Certificate of Mailing

Honorable Assistant Commissioner:

I hereby certify that the attached Response to Office Action and New Claims 28-54 are being submitted via first class mail with the United States Postal Service in an envelope with sufficient postage addressed to "Assistant Commissioner for Patents, Washington, DC 20231" on October 24, 2002.

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New Claims 28-54

Honorable Assistant Commissioner:

New claims 28-54 are attached.

Respectfully submitted this 24th day of October, 2002.

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28. A semiconductor light source for emitting light to illuminate a space used by humans, the semiconductor light source comprising:

an enclosure, said enclosure being fabricated from a material substantially transparent to white light,

a base to which said enclosure is mounted,

an interior volume within said enclosure,

a secondary heat sink located in said interior volume, said secondary heat sink being capable of drawing heat from one or more semiconductors devices,

a plurality of primary heat sinks mounted on said secondary heat sink, each of said primary heat sinks being smaller than said secondary heat sink,

a semiconductor chip capable of emitting light mounted on one of said primary heat sinks, said semiconductor chip being capable of emitting monochromatic light, said semiconductor chip being selected from the group consisting of light emitting diodes, light emitting diode arrays, laser chips, and VCSEL chips,

said chip including a substrate on which epitaxial layers are grown,

a buffer layer located on said substrate, said buffer layer serving to mitigate differences in material properties between said substrate and other epitaxial layers,

a first cladding layer serving to confine electron movement within the chip, said first cladding layer being adjacent said buffer layer,

an active layer, said active layer emitting light when electrons jump to a valance state,

a second cladding layer, said second cladding layer positioned so that said active layer lies between cladding layers,

a first and a second reflective layer, each of said first and second reflective layers being located on opposite sides of said active layer, said reflective layers serving to reflect light emitted by said active layer, and

a contact layer on which an electron may be mounted for powering said chip, and

a coating for converting monochromatic light emitted by said chip to white light.

29. A device as recited in claim 1 further comprising a first and a second reflective layers, each of said first and second reflective layers being located on opposite sides of said active layer, said reflective layers serving to reflect light emitted by said active layer.

30. A device as recited in claim 2 wherein said reflective layers include multiple quantum wells.

31. A device as recited in claim 1 wherein said substrate is selected from the group consisting of Si, GaAs, GaN, InP, sapphire, SiC, GaSb, InAs.

32 A device as recited in claim 1 wherein said substrate is electrically conductive.

33. A device as recited in claim 1 wherein said substrate is electrically insulative.

34. A device as recited in claim 1 wherein at least one of said epitaxial layers includes a material selected from the group consisting of GaN, AlGaN, AlN, AlGaN, GaInN, and GaInN.

35. A device as recited in claim 28 further comprising a phosphor coating on said chip.

36. A device as recited in claim 28 further comprising a power module for powering the light source, said power module including a fitting for installation in a traditional light bulb socket and an AC/DC converter for converting AC power from traditional building wiring to DC power usable by a semiconductor devices.

37. A device as recited in claim 28 wherein at least one of said heat sink includes a material selected from the group consisting of include copper, aluminum, silicon carbide, boron nitride natural diamond, monocrystalline diamond, polycrystalline diamond, polycrystalline diamond compacts, diamond deposited through chemical vapor deposition and diamond deposited through physical vapor deposition.

38. A device as recited in claim 28 further comprising a quantity of heat conductive adhesive located between said chip and said primary heat sink and serving to conduct heat from said chip to said primary heat sink.

39. A device as recited in claim 28 further comprising a quantity of light reflective adhesive located between said chip and said primary heat sink.

40. A device as recited in claim 28 wherein at least one of said reflective layers includes multiple quantum wells.

41. A semiconductor light source for emitting light to illuminate a space used by humans, the semiconductor light source comprising:

an enclosure, said enclosure being fabricated from a material substantially transparent to white light,

a base to which said enclosure is mounted,

an interior volume within said enclosure,

a secondary heat sink located in said interior volume, said secondary heat sink being capable of drawing heat from one or more semiconductors devices,

a plurality of primary heat sinks mounted on said secondary heat sink, each of said primary heat sinks being smaller than said secondary heat sink,

a plurality of wells, said wells being located on said primary heat sinks and being sized to accommodate mounting of a semiconductor chip therein,

a semiconductor chip capable of emitting light mounted in one of said primary heat sink wells, said semiconductor chip being capable of emitting monochromatic light,

a quantity of adhesive serving to secure said chip to said primary heat sink,

said chip including a substrate on which epitaxial layers are grown,

a buffer layer located on said substrate, said buffer layer serving to mitigate differences in material properties between said substrate and other epitaxial layers,

a first cladding layer serving to confine electron movement within the chip, said first cladding layer being adjacent said buffer layer,

an active layer, said active layer emitting light when electrons jump to a valance state,

a second cladding layer, said second cladding layer positioned so that said active layer lies between cladding layers,

at least one reflective layer, said second reflective layer serving to reflect light emitted by said active layer, and

a contact layer, and

a coating for converting monochromatic light emitted by said chip to white light.

42. A device as recited in claim 41 wherein said reflective layer includes multiple quantum wells.

43. A device as recited in claim 41 wherein said substrate is selected from the group consisting of Si, GaAs, GaN, InP, sapphire, SiC, GaSb, InAs.

44. A device as recited in claim 41 wherein said substrate is electrically conductive.

45. A device as recited in claim 41 wherein said substrate is electrically insulative.

46. A device as recited in claim 41 wherein at least one of said epitaxial layers includes a material selected from the group consisting of GaN, AlGaN, AlN, AlGaN, GaInN, and GaInN.

47. A device as recited in claim 41 further comprising a phosphor coating on said chip.

48. A device as recited in claim 41 further comprising a power module for powering the light source, said power module including a fitting for installation in a traditional light bulb socket and an AC/DC converter for converting AC power from traditional building wiring to DC power usable by a semiconductor devices.

49. A device as recited in claim 41 wherein at least one of said heat sink includes a material selected from the group consisting of include copper, aluminum, silicon carbide, boron nitride natural diamond, monocrystalline diamond, polycrystalline diamond, polycrystalline diamond compacts, diamond deposited through chemical vapor deposition and diamond deposited through physical vapor deposition.

50. A device as recited in claim 41 further comprising a quantity of heat conductive adhesive located between said chip and said primary heat sink and serving to conduct heat from said chip to said primary heat sink.

51. A device as recited in claim 41 further comprising a quantity of light reflective adhesive located between said chip and said primary heat sink.

52. A device as recited in claim 41 further comprising a cover over said chip in said well.

53. A device as recited in claim 41 further comprising a coating over said chip in said well.

54. A device as recited in claim 41 further comprising a transparent material located in said well and covering said chip, said transparent material being capable of converting monochromatic light emitted by said chip to white light.